3D/4D CSEM realistic monitoring considerations – is it possible?

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Total with the assistance of WesternGecoEM acquired a rich 3D marine Controlled Source Electromagnetic (CSEM) dataset offshore West Africa toward the end of 2006 (Figure 1.). This dataset was intended to be a definitive validation of the technique or proof of concept over a well understood target for which definitive measures could be made of many different types of analysis and inversion. The dataset was also acquired at the beginning of the fields' life so that the opportunity remained for monitoring the production development electrically.

As is well known, the CSEM technique measures sub-surface resistivity and thus may be a more powerful determination of fluid type/quantity than the traditional acoustic approach (Chuprin et. al. 2008). The inherent power of the direct resistivity measure needs to be balanced against the techniques inherent low resolution and consideration given to any ambiguity in the interpretation that may exist. Fortunately in the reservoir or 4D application, much is known about the target in advance and relatively easier difference measures are sought.

This paper seeks to explore realistic issues and expected responses due to production of the field and to when and how such measurements could be done either individually or in combination with other techniques.

Specifically, forward 3D CSEM calculations will be made of the resistivity model constructed from all available well and seismic data (see Figure 2) of several production scenarios to test the detection limits of the technique for various acquisition deployment concepts.

Specific question to answer will be:

- 1) At nominal production, when will an equivalent 3D CSEM survey detect a change?
- 2) Will a reduced survey (2D line or single receiver) be able to detect changes?
- 3) Can individual reservoir changes be detected?
- 4) Will there be difficulty in differentiating saturation/volume changes?

Consideration will also be given to the impact of significant noise sources from instrumentation, navigation, processing and inversions uncertainty as these form an additional challenge in any monitoring exercise.

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References

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Figure 1. Line and Receiver Location of the mCSEM test.

Figure 2. 3D view of the 3D resistivity model based on all well and seismic information used to interrogate the CSEM responses.